

a first width of the first and second lower electrodes at their upper ends is narrower than a second width in a central portion, in the height direction, of the first and second lower electrodes.--

Remarks

Claims 12-16 and 21-24 are pending in the Application, all of which stand rejected. In response, Applicants have amended claim 12, canceled claim 14 and added new claim 25. Additionally, traversal of the imposed rejections are discussed in detail below.

1. Claims 12 and 14 Rejected under 35 USC 102

Claims 12 and 14 stand rejected under 35 USC 102 as anticipated by Takaishi (US 5,604,696). The Examiner asserts that figures 4A and 4I of Takaishi identically disclose every feature recited in claims 12 and 14. In response, the limitation of claim 14 has been incorporated in claim 12, and claim 14 canceled. Accordingly, no new subject matter has been introduced. Applicants urge that claim 12, as amended, recites features not disclosed by Takaishi and, therefore, respectfully request reconsideration and withdrawal of the rejection under 35 USC 102 of claim 12.

As shown in FIG. 42 of the present application, in the semiconductor device as specified by claim 12 as amended, the insulating film which has first and second openings (61a and 61b) for forming the capacitor lower electrode assembly (i.e., first and second lower electrodes 170a and 170b) includes an upper insulating film (77) and a lower insulating film (58). Specifically, in claim 12 as amended, openings for arranging the first and second lower electrodes (170a and 170b) are formed both in the upper and lower insulating films.

In contrast, in the Takaishi reference, the insulating layer (8), which is identified by the Examiner to be the lower insulating film, does not have any opening for arranging the capacitor

lower electrode therein. Specifically, according to Takaishi, the insulating film having an opening for the capacitor lower electrode formed therein is only the insulating layer 21.

Accordingly, the semiconductor device recited in claim 12, as amended, includes features not disclosed nor suggested by Takaishi.

Applicants respectfully request reconsideration and withdrawal of the rejection under 35 USC 102 of claim 12.

As a result of the differences in the device of Takaishi as compared to the features recited in claim 12, Takaishi's device does not provide a number of benefits realized by the present invention. As shown in FIG. 42 of the present application, the lower insulating film (58), recited in claim 12 as amended, can be utilized as an etching stopper, in the etchings step for providing the opening for forming the capacitor lower electrode assembly in the upper insulating film (77). Further, in the step of annealing performed after the upper insulating film is deposited, there is the lower insulating film (58) between plugs (57a and 57b) and the upper insulating film (77). Therefore, the possibility of undesirable oxidation of the upper surfaces of plugs 57a and 57b leads to the problem that contact resistance between the lower electrodes (170a and 170b) and the plugs (57a and 57b) increases. In other words, the lower insulating film (58) has a function of suppressing the problem of this increase in the contact resistance.

When the polysilicon film to be the lower electrodes (170a and 170b) is deposited, the thickness of the polysilicon film tends to be the smallest at the end portion (corner portion) of the bottom of the opening. Therefore, when a cleaning process using HF liquid is performed after the lower electrodes (170a and 170b) are formed and before forming the capacitor dielectric film, the HF liquid sometimes permeates through the thin portion of the polysilicon (the portion at the end of the bottom of the opening) to portions below the lower electrodes (170a and 170b). In that case, the insulating film 37, for example, positioned below the lower electrodes (170a and

170b) may be eroded by the HF cleaning liquid. This may result in a short circuit of adjacent lower electrodes (170a and 170b) thereby lowering reliability of the semiconductor device. As the semiconductor devices have been miniaturized recently, the polysilicon film to be the lower electrodes (170a and 170b) becomes thin (for example 30nm or thinner). Thus, troubles caused by the permeation of the cleaning liquid become even more serious.

In the semiconductor device in accordance with claim 12 as amended, as can be seen from FIG. 42, an end portion of the lower insulating film (58) can be protruded inward to the openings (61a and 61b) at the bottom of openings (61a and 61b). Therefore, at the corner portions of the bottom of opening (61 a and 61b), the end portion of the lower insulating film (58) can be arranged below the end portion lower electrodes (170a and 170b). Thus, the end portion of the lower electrode film (58) can be utilized as a barrier layer against the permeation of the cleaning liquid described above. As a result, it becomes less likely that the cleaning liquid undesirably reaches the insulating film (37) below the lower insulating film (58).

2. Claims 13 and 21-23 Rejected under 35 USC 103

Claims 13 and 21-23 stand rejected under 35 USC 103 as unpatentable over Takaishi in view of Wang (US 5,856,220). The Examiner admits that Takaishi does not disclose that the part of the insulating film between adjacent first and second electrodes has a width smaller than the minimum working size formable by photolithography. The Examiner asserts, however, that FIG. 12 of Wang discloses this feature and contends it would have been obvious to combine the teachings of these two references in order to reduce wasted space and increase electrode area. With respect to claim 13, the Examiner also admits that Takaishi does not disclose that a side surface of the capacitor lower electrode has a curved plane but that Wang discloses such an electrode in FIG. 12. The Examiner contends that one of ordinary skill would have been

motivated to modify the device of Takaishi in view of Wang "in order to increase electrode area to provide higher capacitance."

In particular to claims 13 and 21-23, Applicants urge that, contrary to the Examiner's contentions, Wang does not disclose the insulating film having a width smaller than the minimum working size formable by lithography as recited in the claims. The sequence of FIGS. 11-13 of Wang depict the formation of the lower electrodes. The Examiner asserts that the isotropic etching of Wang results in an insulating film whose width may be zero. However, Applicants urge that this conclusion is not factually supported by the disclosure of Wang. Wang does not disclose such a hypothetical insulating film width as suggested by the Examiner; instead, Wang discloses an insulating film covered with a metal layer 72 that is then etched using lithography. Thus, Wang discloses that the width of the insulating film is wider than the width of the metal region being removed using conventional lithography. Therefore, in direct contrast to the Examiner's assertion, Wang discloses an insulating film that has dimensions larger than those formable by lithography.

Regardless of what potential geometry isotropic etching might hypothetically create in some unrelated academic exercise, the disclosure of Wang must be factually considered by the Examiner and it is clear that Wang's device is limited to an insulating film that is wider than the limits of photolithography. Thus, the combination of Wang and Takaishi do not disclose or suggest every feature recited in claims 13 and 21-23.

3. Claim 16 Rejected under 35 USC 103

Claim 16 stands rejected under 35 USC 103 as unpatentable over Takaishi in view of Nakano (JP 06125051). The Examiner admits that Takaishi does not disclose that the capacitor lower electrode comprise granular crystals on their surfaces but that Nakano discloses such a

feature. The Examiner contends that one of ordinary skill would have been motivated to modify Takaishi in view of Takano "in order to increase effective electrode area to thus provide higher capacitance."

With respect to claim 16, Applicants urge that the Abstract of Nakano does not reveal granular crystals, as recited in claim 16, but instead discloses an irregular surface created by a separate etching step. Thus, the combination of Takaishi and Nakano do not disclose or suggest every feature recited in claim 16. Accordingly, the applied combination of references does not factually support a prima facie case of obviousness under 35 USC 103 and, therefore reconsideration and withdrawal of the rejection of claim 16 are respectfully requested.

4. Claims 15 and 24 Rejected under 35 USC 103

Claim 24 stands rejected under 35 USC 103 as unpatentable over Takaishi in view of Wang further in view of the admitted prior art (APA). The Examiner admits that Takaishi and Wang do not disclose a) an upper interlayer isolation film (with a contact) being on the capacitor upper electrode, or b) that the capacitor upper electrode extends toward a peripheral circuit. The Examiner contends that the APA stack type DRAM capacitor discloses these features and would "allow electrical access to the upper capacitor electrode ... and allow the contact hole to be made by a non-critical etch step to thus provide more efficient manufacture."

Claim 15 stands rejected under 35 USC 103 as unpatentable over Takaishi in view of Gonzalez et al. (US 5,168,073). The Examiner admits that Takaishi does not disclose that the dielectric film is formed between a side surface of the capacitor lower electrode and the insulating film. The Examiner asserts that FIG. 10 of Gonzalez et al. discloses this feature and contends that one of ordinary skill would have modified Takaishi "in order to thoroughly insulate the bottom electrode from the top electrode ... to prevent shorts and misread and/or lost data."

With respect to claims 15 and 24, Applicants urge that the Examiner has failed to discharge his initial burden of establishing a prima facie case of obviousness because he has not provided a cogent explanation of why one of ordinary skill would have been realistically motivated to modify the references as suggested.

In particular to claim 15, the capacitor of Takaishi, by design, already has the lower and upper electrodes thoroughly insulated. One of ordinary skill, therefore, would not have been motivated to add additional manufacturing complexity and costs, as suggested by the Examiner, in order to solve a deficiency that does not exist in the device of Takaishi.

In particular to claim 24, generalizations such as "to provide more efficient manufacture" have routinely been found inadequate for providing the specific motivation required by 35 USC 103. Instead, the Examiner is required to provide a well-reasoned explanation based on facts, not generalizations, as to why one of ordinary skill would have been impelled to combine the applied references to arrive at the specific arrangement of features recited in claim 24.

Applicants urge that with respect to both claim 15 and claim 24, the Examiner has failed to provide a cogent explanation of why one of ordinary skill would have been realistically motivated to modify the references as suggested and, therefore, respectfully request reconsideration and withdrawal of the rejection under 35 USC 103 of claims 15 and 24.

5. New Claim 25

New claim 25 adds to the features recited in claim 13 by reciting additional features within the embodiment of FIG. 47 and, as such, does not introduce new subject matter. In particular, the claim recites that the width of the lower electrodes 170a and 170b at their upper ends (i.e., the distance between the inner walls of upper portions of the opposing lower electrodes) is narrower than the width at the central portion (from the perspective of the height

direction) of the lower electrodes 170a and 170b. Applicants urge that none of the applied combination of references disclose or suggest all of the features recited in claim 25.

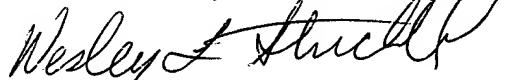
Summary

In view of the above remarks and amendments, Applicants believe that claims 12, 13, 15, 16 and 21-25 are in condition for allowance and passage of this case to issue is respectfully requested.

To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417, and please credit any excess fees to such deposit account.

Respectfully submitted,

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